



NOTES

INTESTINAL DISEASES

GENERALLY, WHAT ARE THEY?

PATHOLOGY & CAUSES

- Diseases preventing adequate digestive system function
 - Often involve inflammation, stasis, obstruction, necrosis
- Various structural, functional etiologies

SIGNS & SYMPTOMS

- Abdominal symptoms etiologically-dependent
- Abdominal pain, distension, constipation, bowel-habit change, hematochezia, nausea, vomiting
- Bulging abdominal mass (in hernia)

DIAGNOSIS

DIAGNOSTIC IMAGING

- CT scan, MRI, ultrasound

OTHER DIAGNOSTICS

- Right lower-quadrant pain common differential (see mnemonic)

TREATMENT

- See individual diseases



MNEMONIC: APPENDICITIS

Right lower-quadrant pain common differential

Appendicitis/ Abscess

Pelvic inflammatory disease (PID)/ Period pancreatitis

Ectopic/ Endometriosis

Neoplasia

Diverticulitis

Intussusception

Crohn's Disease/ Cyst (ovarian)

IBD

Torsion (ovary)

Irritable Bowel Syndrome

Stones

VISIT...

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APPENDICITIS

osms.it/appendicitis

PATHOLOGY & CAUSES

- Lumen obstruction → vestigial vermiform appendix inflammation
- Located at cecum base (near ileocecal valve)
- Obstruction → intraluminal content stasis → ↑ luminal, intramural pressure → thrombosis, occlusion small vessels, lymphatic flow stasis → ischemia, necrosis
- Excessive multiplication (gut flora) behind obstruction → immune system response → fibropurulent reaction → parietal peritoneum irritation
- Visceral nerve fiber stimulation → abdominal pain

CAUSES

- Obstruction
 - Lymphoid hyperplasia (adolescence, viral infection), fecalith, foreign body (e.g. undigested seeds), pinworm infection, tumor (benign, malignant)

RISK FACTORS

- 10–30 years old, family history, biologically-male, cystic fibrosis comorbidity (children)

COMPLICATIONS

- Appendix-supplying vessel compression → ischemia → appendix wall necrosis → bacterial invasion (wall) → appendix rupture → bacterial invasion (peritoneum) → peritonitis
- Periappendiceal abscess, subphrenic abscess, pylephlebitis, portal venous thrombosis, sepsis

SIGNS & SYMPTOMS

- Abdominal pain
 - Often begins in umbilical area → McBurney's point (abdomen's right lower-quadrant; one-third distance from anterior superior iliac spine, umbilicus) → progressive inflammation
 - Rovsing's sign: left lower-quadrant palpated → right lower-quadrant pain
 - Psoas sign: right leg extended in left-side position → retrocecal appendix
 - Obturator sign: right leg internally rotated in supine position → pelvic appendix
- Fever, anorexia, nausea, vomiting, diarrhea/constipation
- In case of peritonitis
 - Rebound tenderness at McBurney's point
 - Abdominal guarding (peritoneal irritation)

DIAGNOSIS

DIAGNOSTIC IMAGING

CT scan with IV contrast

- Increased appendix diameter
- Increased wall enhancement
- Severe
 - Visible abscess, pus spillage

Ultrasound (pregnancy, children)

- Visible, noncompressible, dilated appendix
- ↑ blood flow in appendix wall
- Visible appendicolith
- Right iliac fossa fluid collection

LAB RESULTS

- Neutrophilic leukocytosis
 - ↑ with progression
- Mildly elevated serum bilirubin
 - Perforation marker

TREATMENT**MEDICATIONS**

- Antibiotics
- IV fluids, no food/water orally (NPO)

SURGERY

- Removal (**appendectomy**)
- Abscess drainage

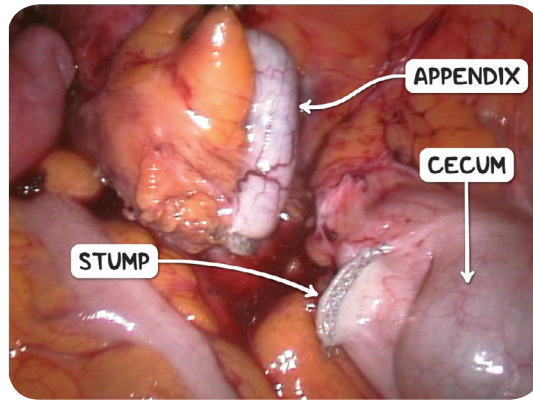


Figure 34.1 Camera view of a laparoscopic appendectomy being performed. The appendectomy has been performed and the stump is visible on the right of the image, with the severed appendix reflected laterally.

DIVERTICULITIS

osms.it/diverticulitis

PATHOLOGY & CAUSES

- Inflamed diverticula; microperforation of diverticulum

CAUSES

- Increased intraluminal pressure → erosion → inflammation, focal necrosis → micro/macro perforation

RISK FACTORS

- Diverticula present

COMPLICATIONS

- Stricture, intestinal **obstruction**
- Diverticulum **perforation**
 - **Abscess**, **peritonitis**
- **Fistula** formation
 - Bladder communication
 - Other organ communication (vagina, skin, other parts of bowel)
 - **Vesicoenteric fistula**: pneumaturia (air in urine), fecaluria (stool in urine)

SIGNS & SYMPTOMS

- **Left lower-quadrant pain** (often sigmoid colon); palpable abdominal mass; diarrhea/constipation; nausea; vomiting; **fever**; urinary urgency/frequency/dysuria (inflamed sigmoid colon → bladder irritation)

DIAGNOSIS**DIAGNOSTIC IMAGING****CT scan with contrast**

- Inflammation → hyperdense tissue

Abdominal X-ray

- Bowel obstruction
- Bowel perforation
 - Free air

LAB RESULTS

- **Leukocytosis**

TREATMENT

MEDICATIONS

- Uncomplicated
 - **Antibiotics**, fluids, no food/water orally (NPO)

SURGERY

- Resection
 - Severe case/recurrence/complication

OTHER INTERVENTIONS

- High-fiber diet
 - Prevents recurrence

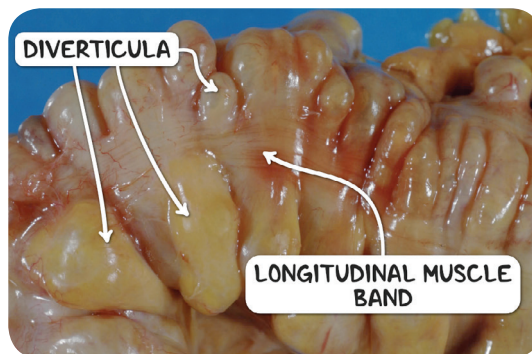


Figure 34.2 Gross pathology of sigmoid diverticulosis. Notice how the diverticula appear either side of the longitudinal muscle.

DIVERTICULOSIS

osms.it/diverticulosis

PATHOLOGY & CAUSES

- **Diverticulum (plural diverticula):** outpouching of hollow anatomical structure wall
 - Most frequent in large intestine (particularly **sigmoid colon**)
- **Diverticulosis:** **multiple diverticula** present

(some areas) → mucosa/submucosa herniation predisposed → diverticulum formation

- **Sigmoid colon:** smallest diameter → highest pressure (Laplace's Law: $P \propto 1/D$), most common location
- **Outpouching:** tend to form where intestinal wall-supplying blood vessels (i.e. vasa recta) traverse muscle layer

TYPES

True diverticulum

- All organ wall layers included (e.g. Meckel's diverticulum)

False (pseudo-) diverticulum

- Only mucosa, submucosa layers included
 - Most common
 - Colonic diverticula

CAUSES

- Multifactorial pathogenesis from abnormal colonic motility
- Abnormal/exaggerated smooth muscle contractions → unequal **intraluminal pressure** distribution → high pressure

RISK FACTORS

- **Lifestyle:** **low-fiber diet**, constipation; fatty food, red meat-rich diet; inactivity; smoking
- **↑ age ↑ risk**
- Biologically-male
- Family history
- Obesity
- Connective tissue disorders
 - Marfan syndrome
 - Ehlers–Danlos syndrome
 - Autosomal dominant polycystic kidney disease

COMPLICATIONS

- Blood vessel surrounding weakened outpouching ruptures → large intestine blood loss → bloody stool
- Inflammation (diverticulitis)
- Segmental colitis

SIGNS & SYMPTOMS

- Often asymptomatic
- Vague abdominal pain, tenderness, bloating
- Occasional cramping
- Altered bowel habit (diarrhea/constipation)
- Rectal bleeding (hematochezia—fresh blood in stool)

DIAGNOSIS

- Often found incidentally

DIAGNOSTIC IMAGING

X-ray with barium enema

- Lower gastrointestinal series
- Directly shows pouches

CT scan

- Visualization of colonic diverticula, thickening of the bowel wall thickening (> 4mm), an increase in soft tissue density within pericolic

OTHER DIAGNOSTICS

Colonoscopy, sigmoidoscopy

- Visible outpouching

TREATMENT

SURGERY

- Resection (if complications develop)

OTHER INTERVENTIONS

- Lifestyle changes
 - Diet (↑ fiber intake), avoid constipation, ↑ physical activity, smoking cessation

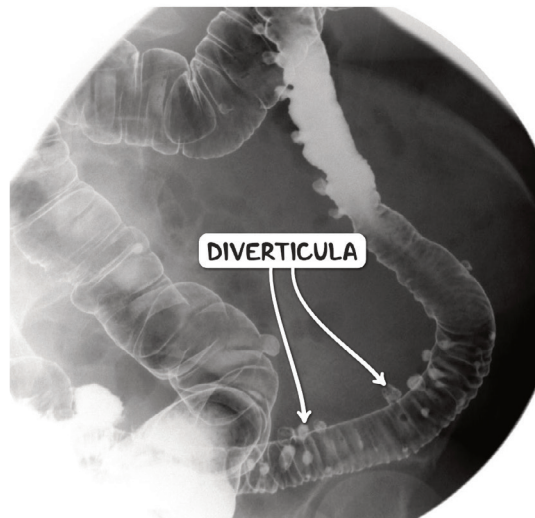


Figure 34.3 Barium study demonstrating multiple diverticula.

FEMORAL HERNIA

osms.it/femoral-hernia

PATHOLOGY & CAUSES

- Intestinal projection **across femoral canal** associated with femoral artery, vein; **below inguinal ligament, lateral to pubic tubercle**

CAUSES

- Congenital, acquired
- Weakness/abnormal fascial opening in abdominal wall
- Usually includes properitoneal fat/omentum edge/small bowel loop

RISK FACTORS

- **Biologically-female**, congenital disorder (embryological development → processus vaginalis obliteration failure), hernia (family history), obesity, pregnancy, frequent heavy lifting

COMPLICATIONS

- Narrow femoral canal
 - ↑ incarceration/strangulation risk
- Compression of femoral vein
- Bowel obstruction

SIGNS & SYMPTOMS

- Asymptomatic (commonly)
- Can manifest intestinal obstruction symptoms
 - Bulging mass, pain, discomfort
 - **Supine**: may resolve
 - **Valsalva maneuver (coughing/straining)**: worsens

- Abdominal contents enter hernia → may precipitate intestinal obstruction
 - Most common cause worldwide
 - **Incarcerated/strangulated**; severe abdominal pain, tenderness, erythema, fever, nausea, vomiting

DIAGNOSIS

DIAGNOSTIC IMAGING

Ultrasound

- Variable echogenicity of tissue; movement of intra-abdominal structures in an inferior direction through the femoral canal

CT scan

- Visualization of characteristic funnel-shaped neck; protrusion through femoral ring

TREATMENT

SURGERY

- Repair
 - Open/laparoscopic (case-dependent)
- Early/elective repair
 - Uncomplicated, asymptomatic hernia
- Urgent repair
 - Complicated hernia (may require bowel resection)

GALLSTONE ILEUS

osms.it/gallstone-ileus

PATHOLOGY & CAUSES

- Gastrointestinal **motility (peristalsis) disruption** → impaired bowel content propulsion
- Blockage → progressive intestine dilation
blockage-proximal, decompression
blockage-distal
- **Gas accumulation** (swallowed air, bacterial fermentation) → ↑ bowel distention
- Bowel wall edema → ↓ bowel content absorption → luminal fluid sequestration
- ↑ capillary permeability → transudative fluid loss from intestinal lumen into peritoneal cavity
- Emesis → fluid, electrolyte (Na, K, H, Cl) loss → metabolic alkalosis, hypovolemia
- Bowel dilation continues → ↓ intestinal wall tissue perfusion → ischemia, necrosis, bowel perforation

TYPES

Onset

- **Acute:** factors such as torsion, intussusception → sudden onset
- **Chronic:** factors such as tumor growth → prolonged onset
- **Recurrent:** often caused by adhesions → intermittent obstructions

Extent

- **Partial:** some of intestinal lumen remains open
- **Complete:** total lumen obstruction

Location

- **Intrinsic:** obstruction within bowel wall—e.g. inflammatory stricture, edema, hemorrhage, foreign body (ingested, parasite accumulation, large biliary calculus)
- **Extrinsic:** obstruction outside bowel wall—e.g. torsion, compression (hernia)

Effect on intestinal wall

- **Simple:** no blood supply impairment
- **Strangulated:** blood supply cut off to bowel section
- **Closed loop:** obstruction occurs at each end of bowel section

Type of factor

- **Mechanical:** obstruction caused by gallstone, neoplasm, adhesion, stricture, hematoma, meconium (in cystic fibrosis), medical device migration (PEG tube)
- **Functional:** intestinal musculature paralysis caused by trauma (surgery, blunt abdominal trauma), peritonitis, medication (opiates, anticholinergics)

RISK FACTORS

- **Surgery:** bowel manipulation, anesthesia, postoperative opioids
- Hernia, neoplasm history, abdominal/pelvic irradiation, chronic inflammation, abdominal trauma

COMPLICATIONS

- Fluid/electrolyte/acid-base imbalance; bowel strangulation, necrosis; perforation; **sepsis**

SIGNS & SYMPTOMS

- Abdominal distension, cramping pain, **constipation**, nausea, vomiting
- **Dehydration:** tachycardia, dry mucous membranes, ↓ urine output
- Bowel sounds
 - **High-pitched “tinkling” sound auscultated:** acute mechanical bowel obstruction
 - **Muffled, hypoactive bowel sounds:** significant bowel distention association
- **Abdominal percussion:** **hyperresonance/tympany**

DIAGNOSIS

DIAGNOSTIC IMAGING

X-ray

- Small intestine, colon distension

TREATMENT

SURGERY

- Surgical intervention: e.g. release adhesions, complete obstructions, repair bowel

OTHER INTERVENTIONS

- No food/water orally (NPO)
- Fluid, electrolyte replacement
- Parenteral feeding → nasogastric decompression



Figure 34.4 A CT scan of the abdomen and pelvis in the coronal plane demonstrating a gallstone in the terminal ileum. If so large that it is unable to pass through the ileocecal valve, the gallstone will cause small bowel obstruction.

GASTROENTERITIS

osms.it/viral-gastroenteritis

PATHOLOGY & CAUSES

- Gastrointestinal tract viral infection (lasts 12 hours–3 days)
- Primary transmission
 - Oral–fecal route
- Viruses → epithelium damage → osmotic diarrhea (> three stools daily), vomiting

CAUSES

- Children: rotavirus (most common)
- Adult: norovirus (most common), astrovirus, adenoviruses

RISK FACTORS

- ↑ morbidity
 - Children, elderly, immunocompromised individuals

- Viral contact
 - E.g. daycare center, cruise ship, closed community outbreak; contaminated food/water

COMPLICATIONS

- Severe dehydration → altered mental status, weight loss

SIGNS & SYMPTOMS

- Watery diarrhea; nausea; vomiting; abdominal cramps, pain; fever; malaise; dehydration (dry lips, skin turgor, tachycardia)

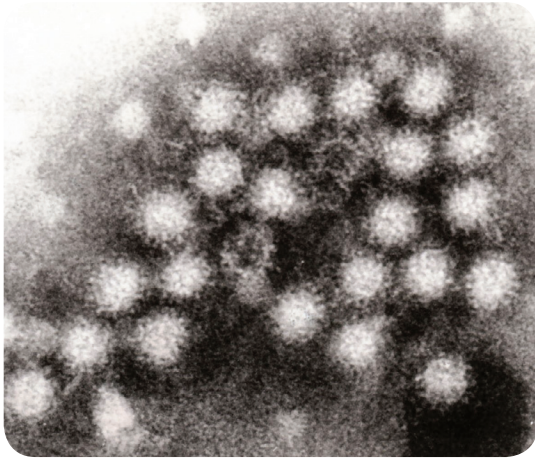


Figure 34.5 A scanning electron micrograph of a cluster of Norwalk virus capsids.

DIAGNOSIS

LAB RESULTS

- Stool sample
 - Excludes bacterial/parasitic etiology
- ↑ C-reactive protein (CRP), ↑ leukocytes
- Polymerase chain reaction (PCR)
 - **Stool, vomit:** enzyme-linked immunosorbent assay (ELISA) performed for rotavirus

TREATMENT

OTHER INTERVENTIONS

- Fluid replacement

Prevention

- Hygiene practices, rotavirus vaccine

INGUINAL HERNIAS

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PATHOLOGY & CAUSES

Direct inguinal hernia

- Peritoneal sac; projects directly **through inguinal triangle** (AKA **Hesselbach's triangle**)
- Projects **medially to inferior** epigastric vessels, lateral to rectus abdominis, pierces parietal peritoneum
- **Hesselbach's triangle composition:** inguinal ligament (AKA Poupart's ligament), rectus abdominis muscle (lateral border), inferior epigastric vessels
- Covered by **external spermatic fascia**

Indirect inguinal hernia

- Most common hernia
- Intestinal projection **through internal inguinal ring**
 - **Location:** spermatic cord (biologically-male), round ligament (biologically-female) exit the abdomen

- **Testicular descent path:** covered by **three layers of spermatic fascia** (three layers); external spermatic fascia (external oblique muscle fascia continuation); cremasteric muscle fascia; internal spermatic fascia (internal oblique muscle fascia continuation)

CAUSES

Indirect inguinal hernia

- **Processus vaginalis closure failure** (i.e. internal inguinal ring and processus vaginalis obliteration failure)

RISK FACTORS

Direct inguinal hernia

- Acquired, affects **transversalis fascia**
 - Chronic intra-abdominal pressure ↑ (e.g. obesity, chronic cough, constipation, heavy lifting—occupational/recreational)
- Abdominal wall musculature atrophy

(aging)

- Older, biologically-male individuals

Indirect inguinal hernia

- Biologically-male individuals > biologically-female individuals
 - Biologically male: late right testicle descent
 - Biologically female: asymmetric pelvis

COMPLICATIONS

Direct inguinal hernia

- Incarceration/strangulation potential

Indirect inguinal hernia

- Can form hydrocele
- May precipitate intestinal obstruction
- Most common cause worldwide

SIGNS & SYMPTOMS

- May be asymptomatic
- Bulging mass (indirect inguinal hernia, mass in groin), pain, discomfort
 - Valsalva maneuver cessation/prone: may resolve
- Valsalva maneuver: worsens projection
 - Coughing/straining

Direct inguinal hernia

- May precipitate intestinal obstruction
 - Most common cause worldwide
 - Incarcerated/strangulated: severe abdominal pain, tenderness, erythema, fever, nausea, vomiting

Indirect inguinal hernia

- Visible bulge
 - May be unapparent in biologically-female individuals
- Incarcerated/strangulated
 - Severe abdominal pain, tenderness, erythema, fever, nausea, vomiting

DIAGNOSIS

DIAGNOSTIC IMAGING

Ultrasound

- Direct inguinal hernia
 - Variable echogenicity of tissue; movement of intra-abdominal structures in an anterior direction through the Hesselbach triangle
- Indirect inguinal hernia
 - Visualization through abdominal wall in biologically-female individuals

CT scan

- Direct inguinal hernia
 - Visualization of a protrusion with compressing inguinal canal contents; inguinal canal pushed into a semicircle of tissue that resembles a moon crescent
- Indirect inguinal hernia
 - Identifies occult hernia/complications; hernia neck visualized superolateral to the inferior epigastric vessels

OTHER DIAGNOSTICS

- Indirect inguinal hernia
 - History, clinical exam; sufficient for majority of suspected inguinal hernias

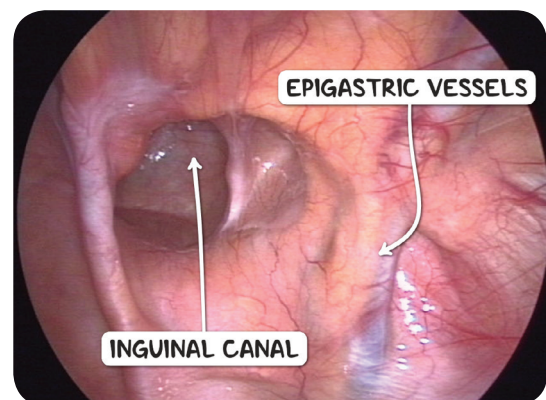


Figure 34.6 Intraperitoneal view of an inguinal hernia during a laparoscopic hernia repair. The peritoneal cavity extends into the inguinal canal, lateral to the epigastric vessels, making this an indirect hernia.

TREATMENT

SURGERY

Repair

- Open/laparoscopic (case-dependent)
- Elective repair
 - Symptomatic hernias
- Direct inguinal hernia (asymptomatic)
 - Monitor, surgical repair preferred

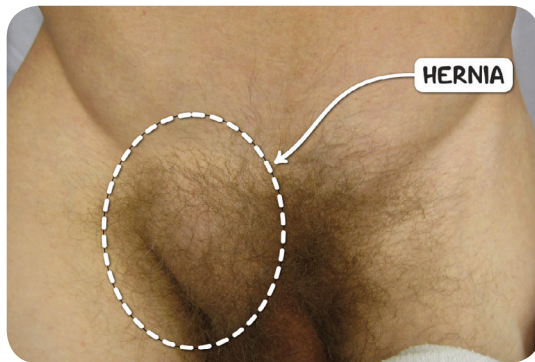


Figure 34.7 Clinical appearance of a hernia in the groin. It is often not possible to distinguish between a direct and indirect hernia on clinical examination alone.

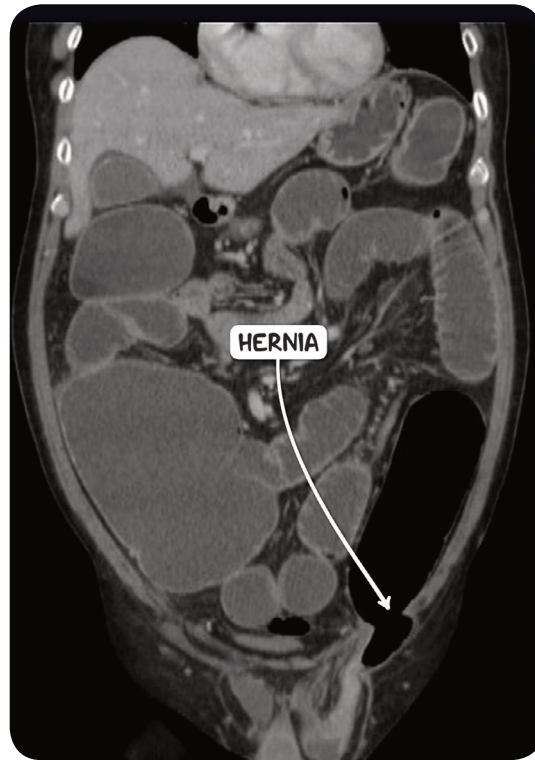


Figure 34.8 A CT scan in the coronal plane demonstrating an indirect inguinal hernia. The proximal bowel is dilated, indicating a strangulated hernia causing obstruction.

INTESTINAL ADHESIONS

osms.it/intestinal-adhesions

PATHOLOGY & CAUSES

- Fibrous tissue bands form physical attachment between intestines → ↓ intestinal motility
- Formed from scarred, post-trauma tissue
- Tissue injury → inflammation → fibrin deposits → fibrin connects parts left (similar to reconstructive “glue”)
- Adhesions extend between tissue if both parts have been injured, close proximity
- Initial fibrous adhesions dissolved by fibrinolytic enzymes

- Injury prevents enzyme secretion → macrophages, fibroblasts deposit collagen into adhesion → permanent

CAUSES

- Surgery (most common), inflammation (cholecystitis, pancreatitis, peritonitis), endometriosis, pelvic inflammatory disease

COMPLICATIONS

- Bowel obstruction, intestinal wall volvulus/ ischemia

SIGNS & SYMPTOMS

- Abdominal pain, vomiting, bloating, constipation

DIAGNOSIS

DIAGNOSTIC IMAGING

X-ray

- Detect obstruction; small intestine dilation

CT scan, ultrasound

- Exclude other obstructive causes

TREATMENT

SURGERY

- Surgical/laparoscopic adhesion excision

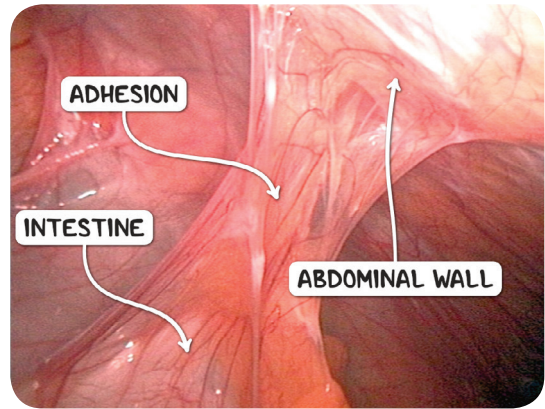


Figure 34.9 Intraoperative view of abdominal adhesions.

INTUSSUSCEPTION

osms.it/intussusception

PATHOLOGY & CAUSES

- Condition that occurs when part of intestine folds into adjacent section → obstruction
- Ileocecal region most commonly affected
- May be idiopathic/caused by abnormal structure (causes pathological lead point) → peristalsis causes one part of bowel to move ahead of adjacent section → bowel telescoping → ↑ pressure, impaired venous return → bleeding, bowel ischemia, infarction

CAUSES

- **Adults:** abnormal growth (e.g. polyp, tumor)
- **Infants:** post-infection lymphoid hyperplasia (Peyer's patches), Meckel's diverticulum

RISK FACTORS

- Most common < 24 months old, intestinal malrotation history, previous intussusception, intussusception in sibling, biologically male

COMPLICATIONS

- Peritonitis, sepsis

SIGNS & SYMPTOMS

- Intermittent abdominal pain (worsens with peristalsis)
- Guarding
- Straining efforts, draw knees toward chest
- Vomiting
- Sausage-like abdominal mass
- "Red currant jelly" stool (blood, mucus)

DIAGNOSIS**DIAGNOSTIC IMAGING****Ultrasound, X-ray, CT scan**

- Telescoped intestine: visualized as classic bull's-eye image
- Intestinal obstruction signs

OTHER DIAGNOSTICS

- May be felt during digital rectal examination (children)

TREATMENT**SURGERY**

- Free telescoped intestine portion → clear obstruction → remove necrotic tissue

OTHER INTERVENTIONS

- Reduction by air/hydrostatic contrast material enema (e.g. saline, barium)

IRRITABLE BOWEL SYNDROME (IBS)

osms.it/IBS

PATHOLOGY & CAUSES

- Chronic functional gastrointestinal system disorder; recurrent abdominal pain, impaired bowel motility
 - No microscopic, macroscopic irregularities
 - Constipation/diarrhea

CAUSES

- Pathology not completely understood; likely multifactorial
 - Visceral hypersensitivity: altered stimuli response
 - Fecal flora alterations; bacterial overgrowth
 - Food sensitivity: short-chain carbohydrates; ↑ water in bowel → smooth muscle spasm, diarrhea; metabolized by bacteria → gas → bloating, spasm, pain
 - Psychosocial influence
 - Genetic factor

RISK FACTORS

- Biologically-female (region-dependent),

previous gastroenteritis, stress

SIGNS & SYMPTOMS

- Impaired bowel motility → diarrhea/constipation
- Recurrent abdominal pain
 - Bowel movement → improvement
- Bloating, nausea, mucus in stool

DIAGNOSIS**OTHER DIAGNOSTICS**

- Based on predominant consistency of stool
 - Diarrhea predominant, constipation predominant, mixed stool pattern, unclassified
- Organic disease exclusion

“Rome IV” diagnostic criteria

- Abdominal pain ≥ one day weekly in last three months, associated with two/more of following
 - Defecation → lessened pain
 - Change in stool frequency
 - Change in stool consistency

TREATMENT

- No definitive cure

MEDICATIONS

- Symptom-guided therapy
 - **Diarrhea predominant:** drugs (e.g. loperamide)
 - **Constipation predominant:** fiber supplementation, adequate fluid intake, osmotic laxatives
 - **Spasm, pain:** antispasmodics

OTHER INTERVENTIONS

- Stress management
- Diet modification
 - Low fermentable oligo-, di-, monosaccharides/polyols diet (low FODMAPs diet)
 - Avoid gas-producing food (caffeine, alcohol)
 - Probiotics
 - Physical activity

ISCHEMIC COLITIS

osms.it/ischemic-colitis

PATHOLOGY & CAUSES

- Inflammatory, ischemic condition; affects colon, most often splenic flexure, rectosigmoid junction
- Sudden blood flow ↓ → insufficient perfusion, oxygen/nutrient delivery to bowel → compromised cellular metabolism → ischemia, inflammation, infarction, necrosis → possible perforation
- Damaged, gangrenous mucosa promotes fluid/electrolyte loss → dehydration, shock, metabolic acidosis

- Hypercoagulable states (e.g. factor V Leiden)
- Biologically-female individuals
- Impaired perfusion (e.g. aortic surgery, myocardial infarction, hemodialysis)
- Vasculopathy
- Certain drugs (e.g. vasopressors)

CAUSES

- Ischemia causes may be occlusive (embolic, thrombotic)/nonocclusive (↓ mesenteric circulation → severe hypotension, vasospasm)
 - Usually acute, may be chronic disorder for marathon runners

RISK FACTORS

- Any cause of ↓ perfusion/mesenteric arterial embolism, thrombosis/vasoconstriction
 - Risk ↑ with age/comorbidities

COMPLICATIONS

- Gangrenous bowel, stricture, pancolitis, colonic perforation, peritonitis, sepsis, shock, metabolic acidosis, multisystem organ failure, reperfusion injury, potentially fatal

SIGNS & SYMPTOMS

- Symptomatology may be self-limiting
- Localized abdominal cramping, tenderness (usually left side)
- Loose, bloody stools, hematochezia
- ↓ bowel sounds
- Guarding, rebound tenderness
- Fever
- May develop shock signs (e.g. hypotension)

CHARACTERISTICS OF ACUTE BOWEL ISCHEMIA BY LOCATION

	SMALL BOWEL (MESENTERIC ISCHEMIA)	COLONIC ISCHEMIA
AGE	Presentation age varies with cause	Risk ↑ with age (> 60 years)
BLOOD SUPPLY	Superior mesenteric artery	Superior, inferior mesenteric arteries; internal iliac arteries
SIGNS & SYMPTOMS	Pain: severe; tenderness develops late in course Bleeding occurs late	Mild, crampy pain; tenderness present Prominent bloody diarrhea, hematochezia
DIAGNOSIS	Imaging, angiography, laparotomy	Imaging, colonoscopy

DIAGNOSIS

DIAGNOSTIC IMAGING

X-ray/CT scan

- Abdominal; visualizes obstruction, perforation, pneumonitis
 - Thumbprinting:** segmented bowel edema/thickening pattern
 - Double-halo pattern:** mucosa, muscularis hyperdensity
 - Pneumatosis coli, pneumoperitoneum indicates perforation

Colonoscopy

- Visualizes ischemia:** edema, erythema, friable mucosa
- Single-stripe sign:** linear ulcer seen along longitudinal axis
- Submucosal hemorrhage:** bluish nodules
- Biopsy:** transmural fibrosis, mucosal atrophy

LAB RESULTS

- Leukocytosis, thrombocytopenia, ↓ hemoglobin
- ↑ serum lactate, lactate dehydrogenase (LDH), creatine phosphokinase (CPK), amylase indicates tissue damage

- Stool culture
- Identifies infectious etiology

TREATMENT

MEDICATIONS

- Antibiotics
 - Perforation/infection

SURGERY

- Bowel resection
 - Necrotic tissue

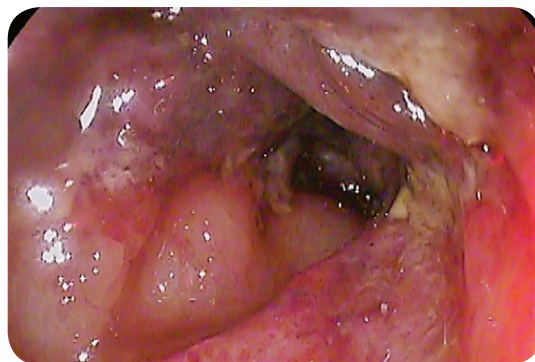


Figure 34.10 The endoscopic appearance of the colon in a case of ischemic colitis. There is mucosal edema and patchy erythema.

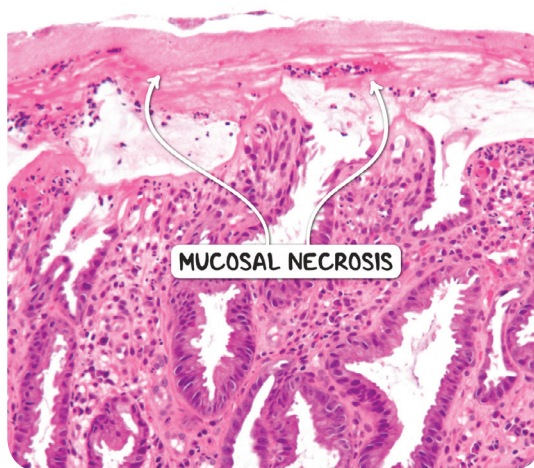


Figure 34.11 Histological appearance of the colon in an individual with ischemic colitis. There is mucosal necrosis, a sign that the condition is in its early stages at the time of biopsy.

OTHER INTERVENTIONS

- Circulatory support
 - IV fluids, electrolytes
- Supplemental oxygen
- Bowel rest

NECROTIZING ENTEROCOLITIS (NEC)

osms.it/necrotizing-enterocolitis

PATHOLOGY & CAUSES

- Severe intestinal disorder: inflammation, ischemic necrosis
 - Terminal ileum, colon (most often affected)
- Multifactorial pathology
- **Preterm infants**
 - **Immature gastrointestinal tract** characterized by ↓ intercellular junction integrity + ↓ mucosal barrier → triggering event → normal intestinal microbiome dysbiosis → ↑ pathogenic bacterial growth → exaggerated immune system response → release of host cytokines, chemokines → tissue injury → necrosis
- Term infants
 - Usually underlying condition adversely affecting intestinal perfusion

RISK FACTORS

- Gestational age < 32 weeks
- Low birth weight < 2kg/4.41lbs
- Dysbiosis-contributing interventions
 - Antibiotics, acid-reducing agents, feeding bovine milk formula
- Human milk promotes commensal bacteria growth, supports mucosal integrity
- Infections, gas-forming organism presence
- Underlying conditions
 - Term infants (e.g. fetal growth restriction, perinatal hypoxia, congenital heart disease, gastrointestinal disorders, sepsis)

COMPLICATIONS

- **Bowel perforation**, ileus, septic shock, metabolic acidosis, coagulopathy, respiratory failure
- Surgical complications

- Strictures, short bowel syndrome
- ↑ impaired neurodevelopmental development risk
- High mortality rate

SIGNS & SYMPTOMS

- Abrupt feeding tolerance change
- Abdominal distension, tenderness
- Erythema, crepitus, induration may also be present
- ↑ gastric residuals
- Vomiting (often bilious), bilious drainage from enteral feeding tubes
- Hematochezia
- Nonspecific findings
 - Temperature instability, lethargy, apnea



Figure 34.12 Gross pathology of necrotizing enterocolitis.

DIAGNOSIS

DIAGNOSTIC IMAGING

Abdominal radiography, ultrasound

- Pneumatosis intestinalis, pneumoperitoneum/hepatobiliary gas

LAB RESULTS

- Positive blood culture, ↓ platelets, ↓ red blood cells, disseminated intravascular coagulopathy evidence, ↑ serum lactate

OTHER DIAGNOSTICS

Surgery

- Through surgical/postmortem specimens
 - **Gross examination:** gangrenous necrosis, hemorrhage, subserosal gas collection
 - **Histological examination:** edema, hemorrhage, transmural necrosis, bacterial infiltration

TREATMENT

MEDICATIONS

- Empirical antimicrobial therapy

SURGERY

- Exploratory laparotomy, bowel resection
- Primary peritoneal drainage (PPD) → ↓ intra-abdominal pressure

OTHER INTERVENTIONS

- Address complications (e.g. metabolic correction/hematologic abnormalities)
- Bowel rest with nasogastric intubation decompression
- Supplemental oxygen/mechanical ventilation
- Fluid replacement
- Inotropic support
- Total parenteral nutrition (TPN)

SMALL BOWEL ISCHEMIA & INFARCTION

osms.it/ischemia-and-infarction

PATHOLOGY & CAUSES

- Serious small bowel condition; reduced blood flow, subsequent infarction; AKA mesenteric ischemia
 - Collateral circulation network → small bowel especially vulnerable to widespread ischemic injury
 - Hypoxia, subsequent reperfusion → tissue injury
- ↓ blood flow may be acute/chronic
 - **Acute:** sudden ↓ small intestine perfusion
 - **Chronic:** episodic ↓ digestion perfusion (often related to mesenteric atherosclerosis)
- Insufficient perfusion, oxygen/nutrient delivery to bowel → compromised cellular metabolism → ischemia, inflammation, transmural infarction, necrosis → bacterial transmigration + possible perforation
- Damaged, gangrenous mucosa promotes fluid/electrolyte loss → dehydration, shock, metabolic acidosis

CAUSES

- Ischemia causes
 - **Occlusive (arterial/venous):** embolic, thrombotic, tumor, volvulus, intussusception, hernia, atherosclerosis
 - **Nonocclusive:** severe hypotension, vasospasm → ↓ mesenteric circulation

RISK FACTORS

- Any cause of ↓ perfusion/mesenteric arterial embolism, thrombosis/vasoconstriction
- Cardiac disorders (e.g. arrhythmia, valvular disease → arterial emboli formation from heart; ↓ cardiac output, peripheral hypoperfusion)
- Procedures (e.g. cardiac catheterization,

cardiopulmonary bypass surgery, hemodialysis → ↓ intestinal perfusion)

- Coagulative disorders
- Atherosclerotic occlusive disease
- Hypovolemia (e.g. dehydration, hemorrhage)
- Bowel strangulation (e.g. volvulus, incarcerated hernia)
- Vasoconstriction medications

COMPLICATIONS

- Ileus, shock, metabolic acidosis, multisystem organ failure, high mortality

SIGNS & SYMPTOMS

- Severe abdominal pain (often postprandial); nausea, vomiting; distended abdomen; guarding, rebound tenderness (develops later); ↓ bowel sounds; fever; feculent breath odor; rectal bleeding; may exhibit shock signs (e.g. hypotension)

DIAGNOSIS

DIAGNOSTIC IMAGING

CT/magnetic resonance (MR) angiography

- Detects acute mesenteric ischemia

Abdominal X-ray/CT scan

- Dilated bowel loops, bowel wall thickening, thumbprinting, intestinal pneumatosis, free intraperitoneal air

LAB RESULTS

- Leukocytosis with left shift, ↑ hematocrit (dehydration, hemoconcentration)
- ↑ serum lactate, amylase, alkaline phosphatase

OTHER DIAGNOSTICS

- Laparotomy
 - Abdominal exploration

TREATMENT**MEDICATIONS**

- Antibiotics
- Circulatory support
 - IV fluids, electrolytes, inotropic medications

SURGERY

- Resection

OTHER INTERVENTIONS

- Pain management
- Bowel rest with decompression

VOLVULUS

osms.it/volvulus**PATHOLOGY & CAUSES**

- Intestinal **obstruction**
 - Intestinal **twisting**/looping

TYPES

- **Classified by location**

Sigmoid volvulus (most common)

- Usually **middle-aged/elderly** individuals
- Causes include pregnancy, chronic constipation (e.g. Hirschsprung's disease), intestinal adhesions

Cecal volvulus

- Causes include impaired abdominal mesentery development, pregnancy, chronic constipation

Midgut volvulus

- Usually **infants/young children**
- Caused by anomalous intestinal development (e.g. intestinal malrotation)

COMPLICATIONS

- **Mesenteric** artery compression → intestinal wall ischemia, **infarction**
- Intestinal wall perforation, infection (e.g. diffuse peritonitis)

SIGNS & SYMPTOMS

- Abdominal tenderness, pain, distension, bilious vomiting, constipation, fever, auscultation (abnormal bowel sounds, often decreased), percussion (tympany), hematochezia (may indicate bowel ischemia, necrosis)

DIAGNOSIS**DIAGNOSTIC IMAGING****X-ray**

- Asses volvulus shape
 - Bent inner tube sign ("coffee bean" sign)

Barium enema

- May show "bird's beak" shape (point of twisted bowel)
- Perforation suspected → barium contrast contraindicated

CT scan

- Twisted mesentery ("whirlpool" sign)

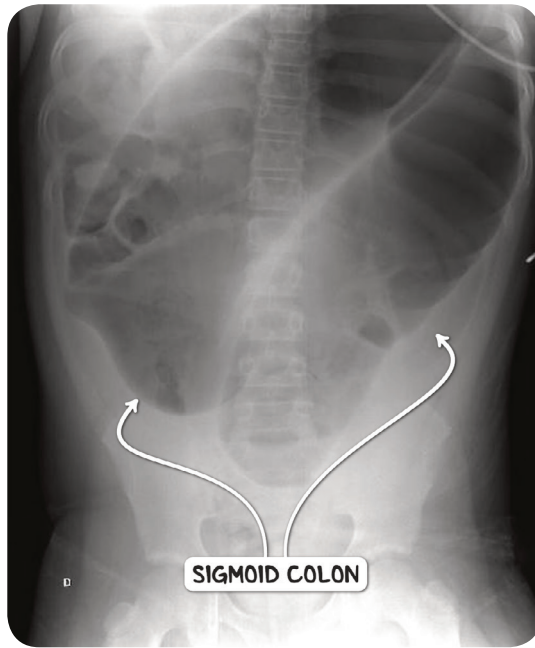


Figure 34.13 Abdominal radiograph demonstrating a massively dilated sigmoid colon in a case of sigmoid volvulus.

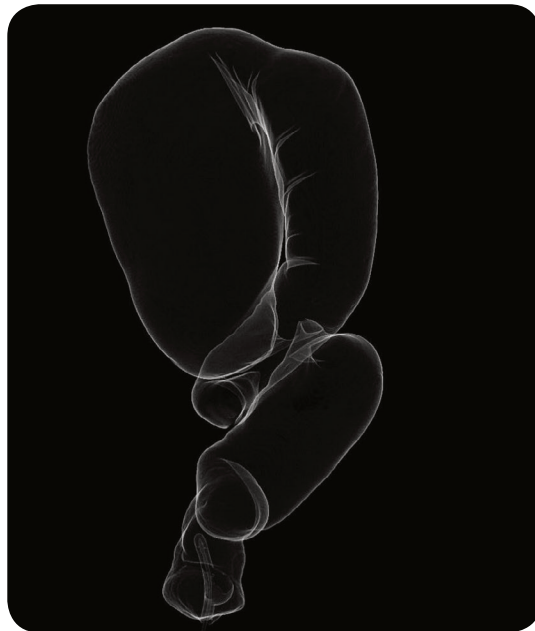


Figure 34.14 3D CT virtual colonoscopy demonstrating sigmoid volvulus.

TREATMENT

SURGERY

- In case of midgut volvulus/ischemia/necrosis; surgical resection if necessary

OTHER INTERVENTIONS

- IV fluid replacement
- Bowel decompression
 - *Sigmoid volvulus*: sigmoidoscopy
 - *Cecal volvulus*: colonoscopy